



# USGS National Land Imaging Program Update

NGAC

28 June 2023

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USGS NLI

Requirements, Capabilities & Analysis

Branch Chief

# Landsat Operations Status

## Landsat 9 (2021 - )

Collecting more than 700 new scenes per day; full mission transitioned to USGS in 2022

## Landsat 8 (2013 - )

Collecting more than 700 new scenes per day; night and off-nadir imaging of volcanos and fire imaging.

## Landsat 7 (1999 - 2022)

Lowered into storage orbit; awaiting NASA satellite rendezvous and refueling; still collecting new imagery



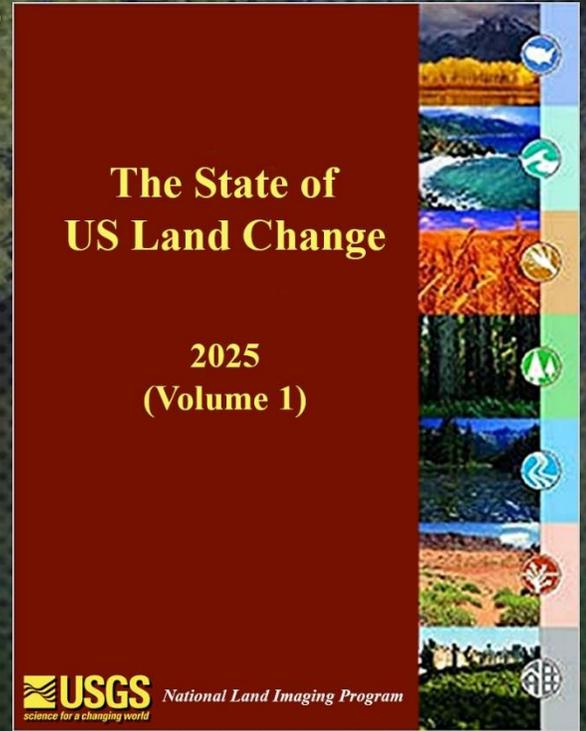
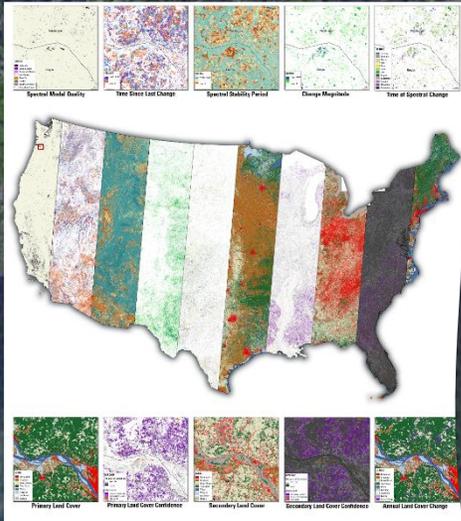
Earth Resources Observation and Science Center (EROS)

## Landsat Archive Operations

Reprocessed Landsat "Collection 2" available on the Amazon Cloud.

On track for more than **17 billion** user accesses this year!

# National NLI Operational Science Products



**Land Change Monitoring, Assessment and Projection (LCMAP)**  
1985-2021

Focusing on change and trends

**National Land Cover Database (NLCD)**  
2001, 2006, 2011, 2016, 2019, 2021 (release in July 2023)

Focusing on accurate thematic cover

**Land Cover Next (LC Next)**  
1985-2024  
2023 - Product Suite Definition  
2024 - LC Next Product Release

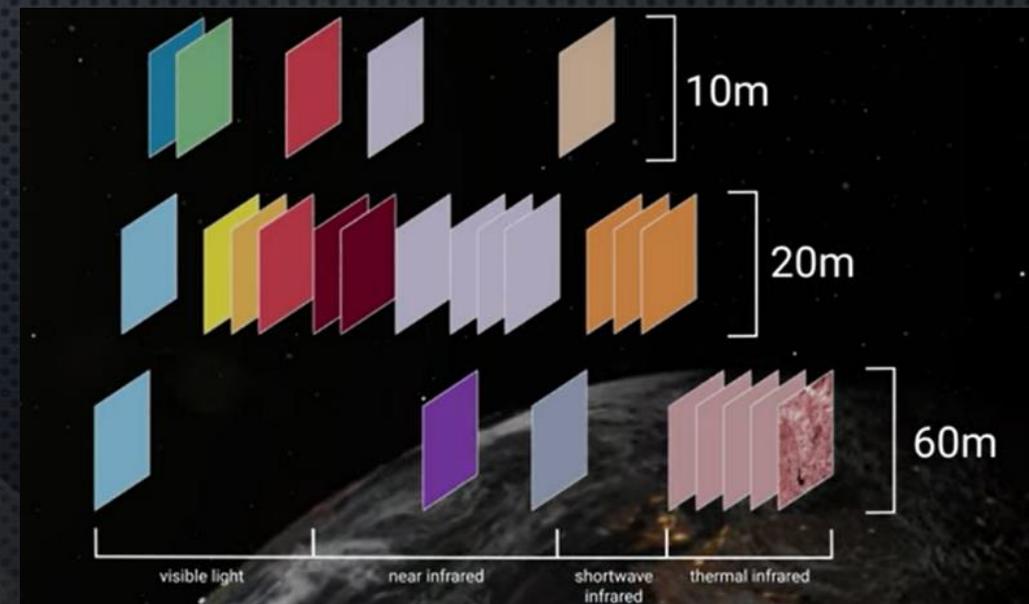
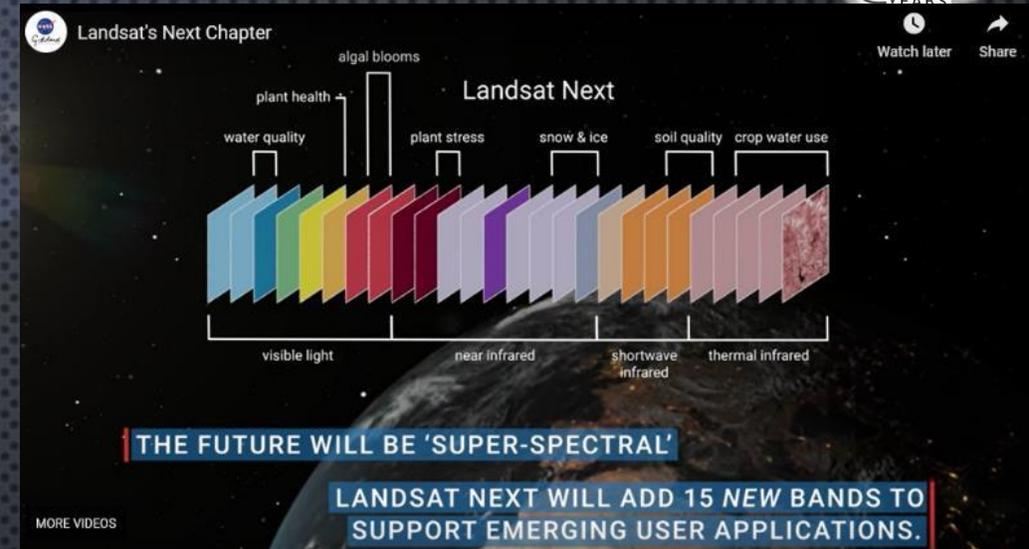
Landsat-based land cover and change

Historical trends, current condition, drivers of change, future risks and vulnerabilities

# Landsat Next Update

- NASA released the Landsat Instrument Suite (LandIS) Final Request for Proposals on May 30th
  - Vendors required to provide responses by July 17th
  - Source selection process includes USGS participation
- This Summer/Fall: USGS conducting studies to better understand the capabilities required to meet requirements for the ground system elements
  - Includes studies for on-board data compression approaches; conducting mission functions in the Cloud; mission operations center alternatives; ground station strategies; etc.

**Landsat Next is in NASA Development Phase A**



# Multi-Decadal Sustainable Land Imaging Program

## First Phase of SLI

Landsat 9



## Second Phase of SLI

Landsat Next



Commercial/Interagency/  
International Partnerships

SLI Technology Development and Infusion (NASA)  
(USGS)

User Needs Development (USGS)

2010



SLI  
Architecture  
Study  
2013-2014

11/22/2017

JSG

SLI  
Architecture  
Study  
2018-2019

04/01/2020

JSG

2020



02/10/2022

JSG

SLI  
Architecture  
Study  
2026-2027

2030



LANDSAT BEYOND

# SLI “Second Phase” Program Activities



- SLI Phase 2 Architecture based on SLI Architecture Study conducted 2018-2020
- Three new elements
  - Landsat Next – Government-managed, contractor-built observing system
    - High-quality calibrated data continuity and traceability with 50-year Landsat data record
    - Supports current and emerging applications with validated user needs
  - Expanded International partnerships
    - Continue international data harmonization efforts with the European Copernicus Sentinel 2 mission and others
    - Provide technical assistance to the Satellite Cross-calibration Radiometer (SCR) project with Australia
  - Commercial Data Program
    - Exploring use of commercially available high spatial resolution / high revisit Visible-Near-Infrared data & services
- Continued investment in user needs assessment and technology development
  - Ensures the state of the art continues to advance for future Earth observation systems in order to meet evolving user needs

***SLI Vision: Long-term operational availability of a wide range of government, commercial, and international land-imaging data and services to meet the Nation’s needs for environmental monitoring and forecasting***

# Landsat Next

- A robust spaceborne, land imaging system to ensure continued collection of data for processing into useful and efficient information products for use by the wide range of interested science communities
- **Mission Concept:** Collection of “superspectral” land observations featuring richer spectral information and higher spatial resolution than Landsat 8 and 9 with improved temporal frequency
  - Intended to replace Landsat 8 to ensure continuity of the Landsat data record in the event of an unexpected Landsat 9 failure on-orbit
- Enables users to:
  - Observe areas experiencing the most rapidly changing landscape from drought, glacier and permafrost melt, harmful algal blooms, and urban heat islands
  - Track and monitor Earth surface condition and change, including their drivers and impacts
  - Predict future risk and vulnerabilities for mitigation and adaptation strategies



NASA “Landsat’s Next Chapter” Video  
<https://svs.gsfc.nasa.gov/14262>

# Landsat Next Requirements Meet Emerging Needs



Multi-spectral → Super-spectral

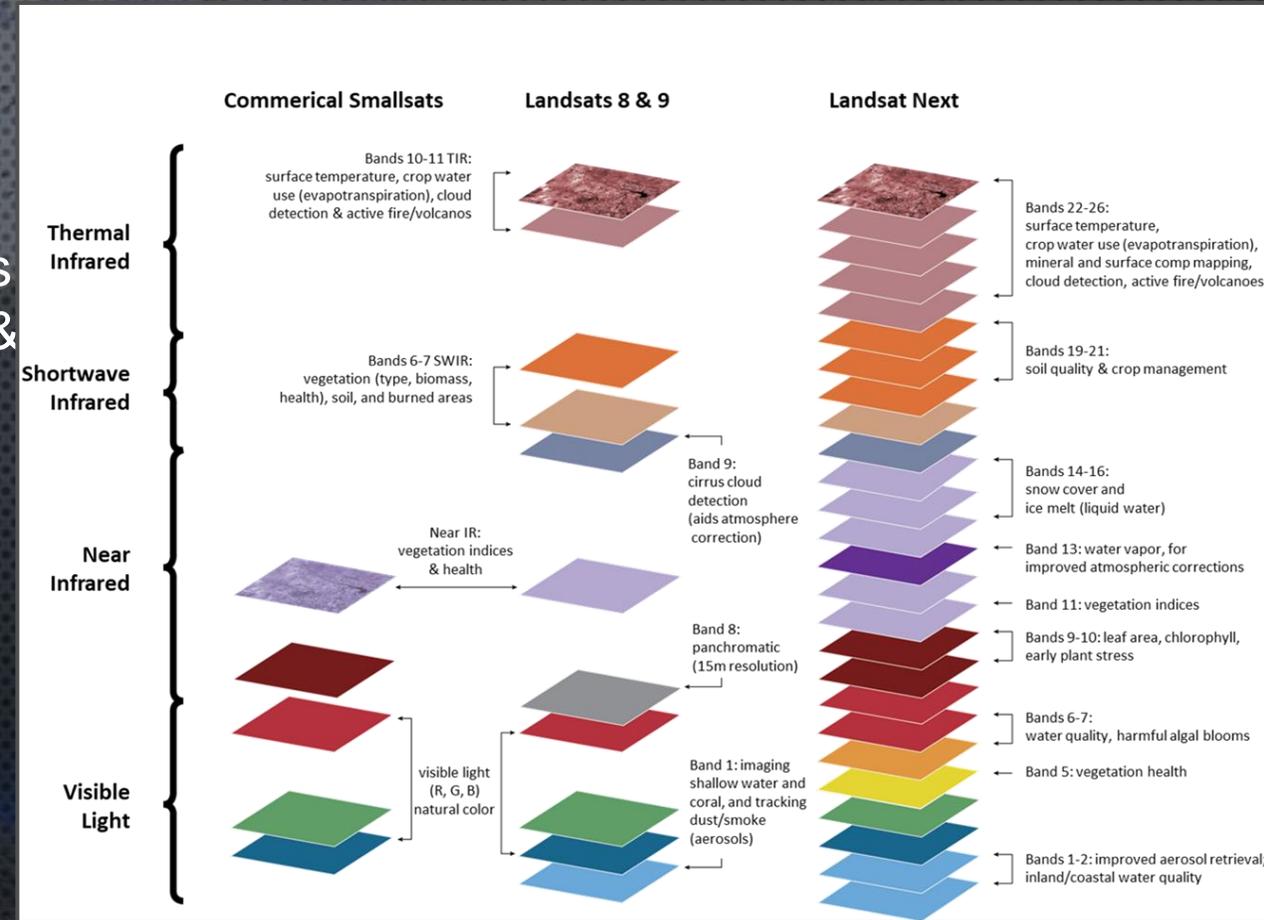
The USGS spent several years engaging with the user community to develop and validate requirements and set priorities for Landsat Next to meet emerging needs while maintaining continuity:

**Improved revisit frequency** to support applications requiring ~weekly clear views, such as crop health & productivity, water quality, snow/ice state, wildfire

**Higher spatial resolution** (10/20-meter data for VSWIR and 60-meter for TIR) to support monitoring of small agricultural fields, forest disturbance, urbanization, and other applications

**Additional spectral bands** to support emerging applications in water quality, snow hydrology, soil mapping, and other areas; improve atmospheric correction and surface temperature retrieval

**Maintaining radiometric quality** established by Landsat 8/9



Landsat Next will provide more than twice as many spectral bands as Landsat 8/9, with spatial resolution improved by a factor of 2, and significantly improved repeat coverage



# Landsat Next Summary

## Landsat Next will continue and improve the 50-year Landsat data record

- Relied upon by Fed/State/local government, commercial, industrial, educational communities
- Landsat is the most widely used land remote sensing data source within Federal civil agencies
- Commercial data providers need Landsat's rigorous calibration standards to build/improve products

## Provides a completely new and improved Landsat for the next generation

- Much better spatial resolution (10meter), twice as many spectral bands (new ones for agriculture, water use, HABs, mineral mapping, volcanos), and improved revisit (6-day) while retaining continuity
- Ensures projected climate change impacts on the land can be rigorously monitored & assessed

## Continues substantial economic benefits to the U.S. economy (~\$2 billion/year)

- Much like GPS and weather data, Landsat data are used every day to help us better understand our dynamic planet – and to continue tracking the effects of global climate change
- Information from Landsat contributes to day-to-day decisions on land, water, and resource use that protect life and property; safeguard the environment; advance science, technology and education; support climate resiliency; and grow the U.S. economy

***Landsat Next ensures future generations will continue to reap the benefits of the Landsat series of measurements--trusted scientific data guiding a myriad of science and operational applications***

# Landsat Programmatic



Federal Landsat activities are funded from two Congressional committees:

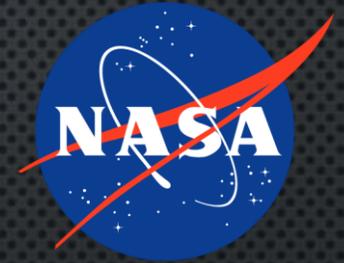
- Commerce, Justice, Science and Related Agencies for all NASA Landsat funding
- Interior, Environment, and Related Agencies for all DOI/USGS Landsat funding

NASA Landsat funding is managed within the Sustainable Land Imaging program of the NASA Earth Science Division

- Development of the space and launch segments
- Technology development

DOI/USGS Landsat funding is managed within the National Land Imaging Program of the USGS Core Science Systems Mission Area

- Development & operation of the ground systems and flight operations
- Development and enhancement of Landsat products
- Collection and analysis of user requirements and capabilities



# USGS and US Civil Space Have a Big Data Problem

- Current USGS Landsat archive is 20PB (NASA's archive  $\approx$  125PB)
- By 2030, the USGS Landsat archive will have grown to 35PB (NASA's archive  $\approx$  325PB)
- In 2031, one year after LNext operations begins, the USGS Landsat archive will be close to 50PB
- NASA, NOAA and USGS together spend billions of dollars each year on Earth Observation (EO) satellite missions. Yet we largely conduct satellite flight operations, data dissemination/access and user needs collection completely independently of each other.
- Similarly, international space agencies (e.g., ESA) and commercial firms also have their own stovepipes for search, discovery and access.



We will not have the infrastructure or services to cost-effectively utilize global EO holdings in the 2030s

1970s

1980s

1990s

2000s

2010s

2020s

2030s

# 2030 Challenge

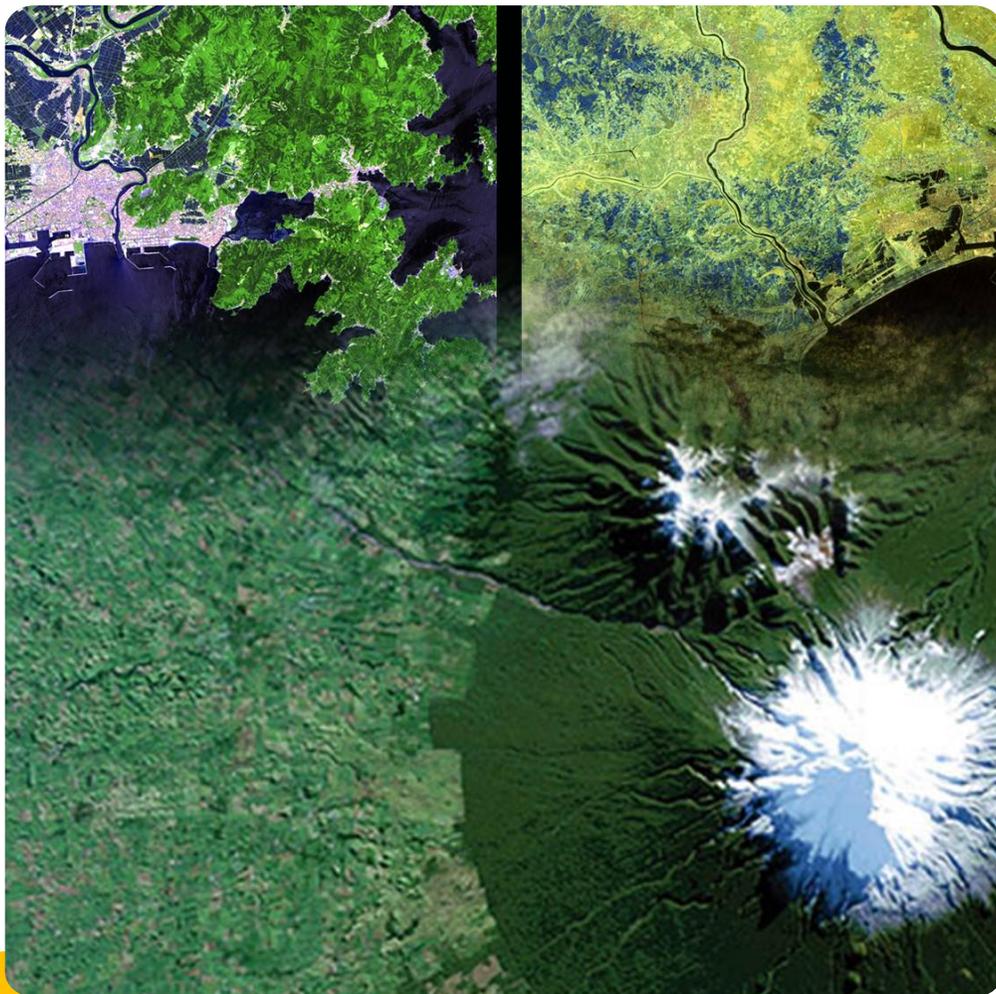
**Remove Stovepipes:** A new collaborative framework of U.S. Civil Earth Observation could truly integrate these activities and products, benefitting science and operational users of the data, and potentially freeing up tens/hundreds of millions of dollars a year that could be used to provide additional Earth Observation missions and data products to meet the ever-increasing needs of the users.

**Cooperative Global Access Standards:** Beyond the U.S. architecture comes the need for common search/discovery access to disparate global archives; cloud agnostic interoperability to enable and encourage multi-source/multi-modal access and exploitation of analysis ready data.

**Start Now:** An integrated U.S. architecture beginning in the 2030 timeframe would provide sufficient time for the agencies to plan for its implementation while not disrupting current missions and projects.

## Ubiquitous Cloud Access and Services Across the Global Archive of Earth Observations





# Various Courses of Action Under Consideration

- **Earth Observation (EO) Product Interoperability**
  - ✓ Already in work through leadership in the Committee on Earth Observation Satellites (CEOS) Analysis Ready Data (ARD) Framework and Product Families
- **Common FedCiv EO Cloud?**
  - Combining the cloud-storage/processing requirements of NASA/NOAA/USGS
    - A private FedCiv cloud infrastructure may be a cost-effective solution...
  - Development of a common FedCiv *storefront* to simplify search/discovery/access of U.S. Government EO products/services
- **Varied business Models to Consider**
  - *'Delivery in the Cloud'* where product customization and egress become *user-pays* services
    - Constrained Product Sets: Only offer calibrated Top of Atmosphere Level 1 products and Level 2 (and Level 3?) products as on-demand *user-pays* service
    - Containerize advanced product algorithms for open science as *user-pays* service in commercial cloud or download to user-provided processing center
  - Move to a Digital Global Grid System (DGGS) as the standard product, moving the industry towards a new standard in data presentation

NGAC FedCiv Challenge:  
Constrain Costs while Enabling/Encouraging Broad EO Exploitation

# 2030 Challenge – Seeking LAG Endorsement

Historically, the three main Federal civil agencies responsible for collection of Space-based and Earth Observations for science and operational uses--NASA, NOAA, and USGS--have largely worked independently to develop and operate their individual systems for collecting, archiving, processing, and distributing data, as well as for conducting satellite flight operations.

While development of the space segments generally follows the NASA model, the operation, ground reception, processing, archiving and distribution functions and satellite flight operations are primarily performed independently by each agency.

With data collection expected to grow by more than an order of magnitude by 2030, it is timely to examine the efficacy of moving to a multiagency Earth observation space system architecture to potentially realize operational efficiencies and cost savings.

The USGS, NASA and NOAA may be able to consolidate similar functional infrastructure and services where technically feasible, to arrive at a robust, shared architecture and service suite that reduces cost for collection, archiving, processing and dissemination of respective agency products.

This federation could also improve search and discovery functionality across Federal civil holdings, improve interoperability of Federal civil products and services, enhance the ability to process and exploit data in a cloud environment, and facilitate concurrent access to Federal, commercial, and foreign Earth observation holdings.

The three agencies and other interested organizations should work together to develop this shared architecture concept, define relevant synergies and use cases, and explore options that efficiently meet stakeholder and user needs into the future.

# EROS 50<sup>th</sup> Anniversary

- **Schedule (August 17-19, Thursday-Saturday):**
  - Day 1: Sioux Falls Foundation/Chamber Ribbon Cutting/Reception
  - Day 2: Formal Rededication Ceremony – EROS Auditorium
  - Day 3: Friends and Family Celebration - 1130 estimated attendees
    - Alumni Stage, Science Lightning Rds, Project Posters, XL Tours
    - Elected Official attendance
    - Celebration Ceremony – Opening of 50-year Time Capsule

If you're interested in attending this event, send an email to: [EROS50thAnniv@usgs.gov](mailto:EROS50thAnniv@usgs.gov) and EROS will send you an invitation.



The card features a background image of the EROS Center building. At the top left is the USGS logo with the tagline "science for a changing world". A yellow banner at the top right contains the dates "August 17-19, 2023" and the address "USGS EROS Center, 47419 252nd Street, Sioux Falls, SD 57198". The main title "SAVE THE DATE EROS 50th Anniversary" is written in large, stylized blue and yellow letters. Below this, the schedule is listed for each day: Thursday, August 17 (Evening Reception), Friday, August 18 (EROS Center Rededication), and Saturday, August 19 ("Friends and Family" Celebration at EROS). At the bottom, there is a large "EROS 50" graphic with a satellite and Earth, and the text "1973-2023" and "50 YEARS EXPLORING OUR PLANET".

**USGS**  
science for a changing world

**August 17-19, 2023**  
USGS EROS Center, 47419 252nd Street, Sioux Falls, SD 57198

**SAVE THE DATE**  
**EROS 50th Anniversary**

**Be our guest as the Earth Resources Observation and Science Center celebrates its 50th Anniversary!**  
Join EROS Center leadership as they host a special event for friends, family, and Center alumni to honor 50 years of service to our community, our nation, and to the world.

**Thursday, August 17**  
**Evening Reception**  
Downtown Sioux Falls, hosted by the Chamber of Commerce and Sioux Falls Development Foundation for special guests, employees and alumni

**Friday, August 18**  
**EROS Center Rededication**  
1:00 pm for government officials and community stakeholders

**Saturday, August 19**  
**"Friends and Family" Celebration at EROS**  
Special guests, alumni, employees, friends, and families are invited to enjoy a day of events on the EROS Campus. The celebration will include special tours, lightning talks by current staff and alumni, special presentations about the kind of work performed at EROS every day, and a celebration ceremony commemorating the event!

The Celebration promises to be a memorable event for all ages and interest levels. Please watch our [EROS 50th Anniversary planning website](#) or email [EROS50thAnniv@usgs.gov](mailto:EROS50thAnniv@usgs.gov) for more information.

**EROS**  
**50**  
1973-2023  
50 YEARS EXPLORING OUR PLANET